

# Four Dimensional Equalizer and Far-End Cross Talk Canceler in Gigabit Ethernet Signals

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## Abstract of the Disclosure

*Sub A2* > A multidimensional equalizer and cross talk canceler for a communication network that simultaneously removes far end cross talk (FEXT) and intersymbol interference (ISI) from a received signal. A multidimensional-pair channel is treated as a single multidimensional channel and a receiver in the communication network equalizes received signals through the use of the multidimensional equalizer. A decision feedback equalizer determines a multidimensional steepest descent gradient to adjust matrix coefficients that are proportional to estimates of

$$\frac{\partial e_n}{\partial Q_k^{i,j}}, \text{ wherein } Q_k^{i,j} \leftarrow \left( Q_k^{i,j} - \mu \cdot \left( \frac{\partial e_n}{\partial Q_k^{i,j}} \right) \right)$$

and

$$\frac{\partial e_n}{\partial Q_k^{i,j}} = 2 \cdot (Z_n^i - X_{n-p}^i) \cdot Y_{n-k}^j.$$

The equalizer includes:

- a vector data unit delay operator that passes the received data vector  $Y_n$  through a series of unit delay operators to generate successive tap input data  $Y_n, Y_{n-1}, Y_{n-2}$ ;
- a first matrix multiplication operator that receives a  $1 \times N$  matrix  $Y_{n-k}$  from the unit delay operator and multiplies it with the  $N \times 1$  matrix of scaled vector error data  $(Z_n - X_n)$  to generate a  $N \times N$  adjustment matrix;
- a matrix summation operator that adds the adjustment matrix to a  $Q_{n-k}$  tap matrix and outputs a corrected tap matrix  $Q_{n-k+1}$ ;
- matrix tap unit delay operator that receives the corrected tap matrix  $Q_{n-k+1}$ , and introduces a one cycle delay to generate a  $Q_{n-k}$  tap matrix; and
- a second matrix multiplication operator that multiplies the  $Q_{n-k}$  tap matrix from the matrix tap unit delay operator by the  $Y_{n-k+1}$  vector from the vector data unit delay operator.